The Afghanistan Engineering Support Program assembled this deliverable. It is an approved, official USAID document. Budget information contained herein is for illustrative purposes. All policy, personal, financial, and procurement sensitive information has been removed. Additional information on the report can be obtained from Firouz Rooyani, Tetra Tech Sr. VP International Operations, (703) 387-2151.

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ENGINEERING SUPPORT PROGRAM

WO-A-0090

Tarakhil Thermal Power Plant – HDPE Fire Water Distribution Piping Assessment Report

April 2, 2013

This publication was produced for review by the United States Agency for International Development. It was prepared by Tetra Tech, Inc.

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April 2, 2013

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Re: WO-A-0090 Tarakhil Thermal Power Plant – HDPE Fire Water Distribution Piping Assessment Report

[redacted]

Enclosed is the Draft report for Tarakhil Thermal Power Plant's HDPE fire water distribution piping system. The report details the history of problems with Tarakhil Thermal Power Plant's HDPE fire water distribution piping as well as possible short term and long term solutions for the piping.

I look forward to meeting with you at your convenience to discuss this report.

Respectfully,

[redacted], P.E.
Chief of Party (AESP)
Tetra Tech, Inc.

Cc: [redacted] P.E., COR Tarakhil Thermal Power Plant (USAID-OEGI)
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AFGHANISTAN ENGINEERING SUPPORT PROGRAM

WO-A-0090
TARAKHIL THERMAL POWER PLANT - HDPE FIRE WATER DISTRIBUTION PIPING ASSESMENT REPORT

April 2, 2013

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Executive Summary

USAID requested the Tetra Tech (Tt) Afghanistan Engineering Support Program (AESP) to perform an assessment of the existing HDPE fire water distribution piping, a major component of the fire suppression system at Tarakhil Thermal Power Plant (TPP) near Kabul, Afghanistan. Currently, the HDPE piping leaks when the system is pressurized.

The objective of this work order was for Tt to provide a report composed of a short technical evaluation of the current HDPE fire water distribution piping, a background of the previous problems with the current HDPE piping at Tarakhil TPP, and short-term and long-term alternatives and recommendations with estimated costs to correct defective fire-suppression system component(s). Tt performed two site visits to Tarakhil TPP on March 19, 2013 and March 26, 2013 to collect data and discuss the ongoing problems with Tarakhil TPP personnel. These personnel were on-site during the fire suppression system construction and involved with the subsequent repairs. Given the limited design and construction information available for the fire suppression system, Tt's discussions and site visits with plant personnel serve as the basis for the technical assessment of the HDPE fire water distribution piping within this report.

There are currently five documented leaks in the HDPE fire water distribution piping that have been identified since the HDPE piping was pressure tested on June 5, 2012. The pressure test was performed as part of the USAID AESP WO-LT-0057 "Fire Suppression Systems Assessment at Tarakhil Thermal Power Plant." One of the recorded leaks is underground, two of the leaks involve water hydrants that have leaking seat valves, one leak is on the above ground gate valve in the pipe connection to Treatment House #2, and one leak was on the Power-House Building A connection, however this last leak has recently been repaired.

Short and Long Term Alternatives were evaluated based on reliability, cost, and construction time. Three short term alternatives were developed to quickly and temporarily provide fire suppression to the three Power-House Buildings (A, B, and C) while permanent deficiency repairs are performed on the existing HDPE fire water distribution system. USAID has stated that restoring the Power-House Building fire suppression system as soon as possible is of paramount importance for insurance purposes.

The recommended short term alternative is Short Term Alternative 1, Provide Temporary Fire Suppression Using the Existing Pump and New Temporary Lines. Short Term Alternative 1 would cost approximately $28,000 and take approximately three weeks to complete.

Three Long Term Alternatives were developed to provide permanent restoration of the entire fire suppression system throughout Tarakhil TPP. This could be accomplished by repairing or replacing existing defective HDPE fire water distribution piping.

The recommended long term alternative is Long Term Alternative 1, Total Replacement of the Water Distribution System. Long Term Alternative 1 would cost approximately $297,000 and take approximately nine weeks to complete.

Included in the cost estimates are flexible connections that should be installed on the buildings connected to the HDPE pipe-loop. There have been significant repairs on all of the Power-House Building connections. Since these building connections are rigid

pipes, slight differential settlement of the soil or seismic activity can put tremendous stresses on the ridged pipe building connection joints. The approximate cost to install flexible connections at Power-House Buildings A, B, and C is an additional $1,800. The approximate cost to install flexible connection at all buildings (10 total) is an additional $6,000. Flexible fittings at all the building connections are included in the recommended long term alternative - Long Term Alternative 1, Total Replacement of the Water Distribution System cost estimates.

Regardless of the alternatives chosen, any new piping should be installed under stringent QA and QC procedures, including the selection of the construction contractor (potential contractors should be evaluated on reputation and cost), a thorough shop drawing review process, compacted backfilling, pipe pressure testing, and construction observation.

1.0 Background

The construction of the Kabul, Afghanistan Tarakhil Thermal Power Plant (TPP) was completed in 2012. Black and Veatch (B&V) was the design and construction engineer for the project. However, since 2012, B&V has demobilized and no longer has a presence at Tarakhil TPP. Operation and ownership of the Tarakhil TPP has been transferred to Da Afghanistan Breshna Sherkot (DABS). Problems with the HDPE fire water distribution piping have reportedly been an ongoing problem since pipe construction was completed in November 2010. Five (5) leaks have developed since B&V has demobilized from the site.

Tetra Tech (Tt) was first made aware of this issue when a study was performed to assess deficiencies in the fire suppression system in June 2012 as part of USAID Afghanistan Engineering Support Program (AESP) WO-LT-0057 "Fire Suppression Systems Assessment at Tarakhil Thermal Power Plant." The assessment involved a visual inspection of the fire suppression system and a summary report of the findings. As part of the study, Tt witnessed a pressure test of the HDPE piping. During the June 2012 site visit, [redacted], B&V Program Director, stated that "all of the defective fused HDPE joints had been unearthed and repaired, but a record of testing was not available." B&V had agreed to pressure test the piping using the Plastic Pipe Institute (PPI) test procedure proposed by Tt in the WO-LT-0057 "Fire Suppression Systems Assessment at Tarakhil Thermal Power Plant – Final Report" submitted on June 26, 2012.

The PPI testing procedure is as follows:

1. Increase the system pressure to one and a half (1.5) times the design working pressure for approximately four (4) hours
   a. Tarakhil TPP design pressure equals 125 psi
   b. 125 psi X 1.5 = 188 psi

2. Reduce the pressure by 10 psi for one hour, the pressure must remain within 5% of this reduced value for the test to indicate no leaks in the pipe system at the time of testing
   a. 188 psi – 10 psi = 178 psi
   b. - 5% of 178 psi = 169 psi
   c. + 5% of 178 psi = 187 psi

The test outlined above was conducted on June 5, 2012. The results of this test can be found in the WO-LT-0057 "Fire Suppression Systems Assessment at Tarakhil Thermal Power Plant – Final Report" submitted on June 26, 2012 in Section 2.2.3 "Pressure Testing". The Final Report shows the test pressure dropped from 178 to 173 psi, approximately 2.8%. This indicates that the pipe should hold the working pressure of 125 psi. However, the system developed another leak 17 days after the test.

Reports of continued leaking in the HDPE piping during system pressurization are the basis for the WO-A-0090 Tarakhil Thermal Power Plant HDPE Fire Water Distribution Piping Assessment Report. Tt conducted a site inspection on March 19, 2013 to gather data and discuss the specifics of ongoing problems with the HDPE piping with DABS personnel. Tt met with Engineer [redacted], DABS Tarakhil TPP Manager, and [redacted], an

ex-B&V employee who currently works for DABS. [redacted] was working for B&V as the Training Coordinator and was on-site during the construction of the HDPE piping as well as the recent pipe repair work. During the site visit, Tt and DABS discussed the history of the HDPE piping failures and subsequent repairs. Engineer [redacted] provided a drawing which identifies the location of the piping repairs and the date on which the piping repairs occurred, see Appendix 1, "Pipe Repair Location from DABS." Tt added the repair designation number and repair type to this drawing from the documents in Appendix 2, "DABS Fire Suppression System Reports." [redacted] USAID OEGI, and [redacted] P.E., USAID OEGI COR – Tarakhil Thermal Power Plant, also attended this site visit.

Although [redacted] was not involved in the installation of the HPDE piping, he was involved in the B&V management team discussions related to many aspects of the Tarakhil TPP construction. According to [redacted] recollection, the original construction of the HDPE piping was conducted with inadequate quality assurance (QA) and quality control (QC). [redacted] added that he did not see any back filling compaction of the pipe trench during construction and expressed concerns that the system appeared to have no provisions to protect against seismic activity on the pipe joints. [redacted] further recalled that the fused joints of many of the HDPE pipes were suspected of being insufficiently heated. Engineer Ahmadzi reported that DABS was not allowed to photograph repairs being made to the pipes when the plant was under B&V's control.

Following evaluation of the data received during the March 19, 2013 site visit, Tt initiated further discussions with Engineer [redacted] that resulted in a second site visit on March 26, 2013. Engineer [redacted] provided Tt with two (2) documents: the first document, a spreadsheet detailing break and repair dates, the contractor who made the repairs, and how long the fire water pump station was turned off; and a second document containing a historical account of the HDPE fire water distribution piping from the start time of construction in September 2010 to present. These documents can be found in Appendix 2, "DABS Fire Suppression System Reports."

During the March 26, 2013 meeting, the focus of discussion was about two (2) items: Item 1, "How did the joints fail?" and Item 2, "What is the main cause of the failures?" [redacted] confirmed that B&V had studied these two (2) items and examined several failed heat-fused joints. It was discovered there was only partial fusing in the joints and that portions of the failed fuses had "bare HDPE surfaces," as described by [redacted], that were unaffected by the heat fusion process. [redacted] in a March 27, 2013 telephone conversation with Tt, said B&V "had concerns that inadequate heat was used in the heat-fusion process on some of the HDPE joints." An example of a failed heat-fused joint is shown below in Figure 1, "Failed HDPE Heat-Fused Joint."

Figure 1 – Failed HDPE Heat-Fused Joint (Courtesy B&V)

It is unknown at this point, how many of the existing estimated 436 heat-fused joints (See Table 1, "Number of Valves and Fittings in the System") in the HDPE piping are inadequately fused (See Table 2, "Number of Joint Failures within the System"). The data in Table 1 and Table 2 have been populated based on information and estimates available for the system provided by others.

Table 1
Number of Valves and Fittings in the System

Item	Number	Notes
Valves	27	Including Risers at buildings and Fire Hydrants
Tee Fitting	25	Include FH T Fittings
Elbow Fitting 90°	27	
Fire Hydrant	12	
Cross Fitting	1	
Approximate Number of Joints	436	
Length of Pipes (meters)	1,280	
Length of Fire Hydrant Pipes (meters)	48	

Table 2
Number of Joint Failures within the System

Type of Joint Failures Reported	Number of Joint Repairs	Approximate Number of connections in the System*
Tee to Pipe	9	75
Elbow to Pipe	5	54
Flange to Pipe	11	54
Pipe to Pipe	7	204
Flange to Tee	1	16
Flange to Elbow	1	3
Reducer to Pipe	1	21
Reducer to Flange	2	9
Totals	**37**	**436**

*Estimated based on data Tt received from DABS and in Appendix 2, DABS Fire Suppression System Reports.

There are slight differences in the total number of recorded HDPE pipe repairs that have been performed to date. According to the information received from DABS, around 40 "pipe-leak" repairs have been made since November 2010 when construction had been completed on the HDPE piping. Several of the reported pipe repairs were associated with leaking seats on fire hydrants, gate valve flanges, and connecting pipes to the Power-House Buildings. The 40 remaining pipe repairs were on heat-fused joints on the main 250 millimeter (mm) HDPE pipe-loop; primarily near tees.

Repairs documented as "near tees and elbows" may have actually been work done on the flange connections because most of the HDPE pipe gate valves are located near tee and elbow fittings. Tt took a photograph of a repair done on an HDPE heat-fused joint and the HDPE-metal flange fitting that was used to transition from HDPE to the metal flange of the gate valve when on site in June 2012, see Figure 2, "Excavated HDPE Pipe Repairs" below.

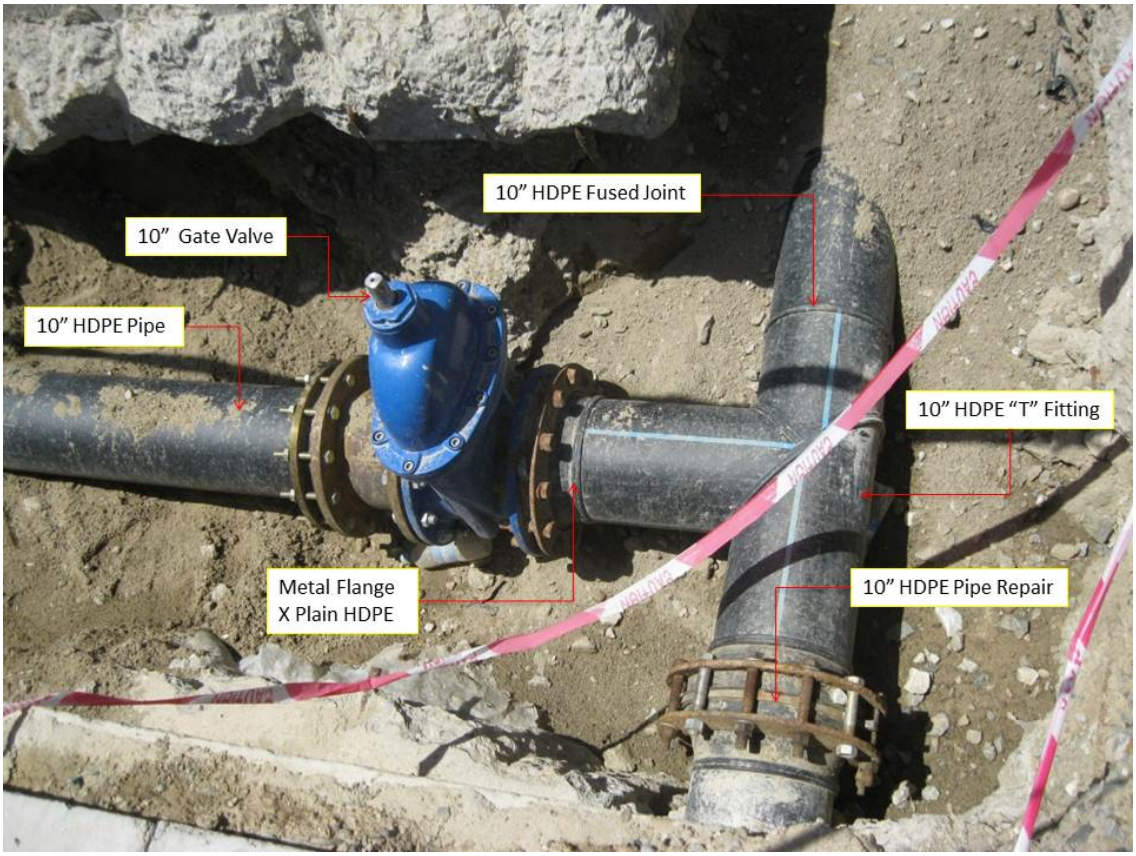


Figure 2 – Excavated HDPE Pipe Repairs

DABS reported that all excavated and reheated fused repairs to leaking HDPE piping have held. B&V coordinated these repairs to be completed by Kabul Amo Water Supply & Construction Company (KAWCC). As previously shown in Figure 1, "Failed HDPE Heat Fused Joint," is a photograph of an HDPE heat-fused joint failure that [redacted] B&V, said was typical to other failed joints he had seen. Tt was told B&V had used a "clamping harness" to repair several leaking HDPE pipe joints. [redacted], B&V, provided Tt with a manufacturer's cut sheet of the harness he said was used to repair three (3) HDPE pipe joints. The clamping device is a spit-sleeve fitting manufactured by Vitalic, Style 995. The sleeve has rubber seal gaskets on both ends that are squeezed when the sleeve bolts are tightened to create a water tight sleeve around the HDPE heat-fused joint. It offers an alternative to the reheated fused joint repair method.

During both Tt site visits, the HDPE piping was not in service and not pressurized. Since the June 2012 pressure test, five (5) leaks in the HDPE pipe system have been documented by DABS. These leaks are listed below.

- Two (2) leaks are related to the seats of fire hydrants, DABS is having problems procuring spare parts;
- One (1) leak was in the 200 mm pipe connection to Power-House Building A, however, the leaking joint was excavated and re-fused on July 11, 2012;

- One (1) leak is in the above ground gate valve in the pipe connection to Treatment House #2; and
- One leak (1) is in the gate valve located near the southeast corner of Power-House Building C. The valve is covered by approximately twelve inches (12") of concrete. When the valve leaks, water discharges up through the valve operator sleeve opening in the concrete. Since the leak has not been excavated, it is unknown if the leak is in the heat-fused joint or the valve flange connections. This area needs to be excavated to determine source of the water leak.

Refer to Appendix 3, "Existing System Deficiencies" for the location of the five (5) recorded system leaks.

Predicting future failure of joints is highly unreliable. A high percentage of the tee connections in the system have been excavated and reheat-fused and the HDPE piping is buried, making visual inspection costly and difficult. However, very few joints in long straight sections of the pipe-loop have failed.

Within the HDPE pipe industry, it is recognized that "joints made following standard procedures and in optimum environmental conditions have mechanical properties approximately as good as those of the parent pipe." This is one of the most attractive properties of heat-fused HDPE pipe. It can be installed without thrust blocking or restraint harnesses that are commonly used with push-on joint pressure pipe. Based on data supplied by DABS, PE100 – Pn10 HDPE pipe was used in the system. The working pressure rating for PE100 – Pn10 HDPE pipe is 145 psi while the operating pressure of the Tarakhil TPP system is 125 psi.

Engineer [redacted] confirmed, since June 22, 2012, the HDPE system was pressurized one time for 48 hours and then on four other occasions for about one hour or one-half hour. During the May 26, 2013 site visit, the jockey pump was started and the HDPE fire water distribution piping was pressurized to 125 psi. The pressure rapidly dropped upon pressurization, possibly due to existing leaks discussed above. [redacted] stated, from his experience, small leaks in the piping system could correspond to rapid pressure drops. The entire pipe system needs to be leak free to hold a pressure of 125 psi.

There are twelve (12) fire hydrants in the HDPE piping system. Of the current five (5) reported leaks in the HDPE piping, two (2) involve leaking fire hydrants. DABS personnel stated that the leaks cannot be repaired because DABS does not have the replacement parts for the hydrant seat valves. If the hydrant seat valves are not replaced, the combined rubber and metal seat parts within the hydrant will likely continue to be damaged beyond repair.

In order to repair the existing fire hydrants, DABS needs replacement parts. A stockpile of spare parts should be ordered so these replace parts are on site if future repairs are needed.

The existing fire hydrants are dry type pillar hydrants Model Number 150NFH-1200 manufactured by National Fire Fighting Manufacturing FZCO (NAFCCO). The contact address of this company is shown below.

National Fire Fighting Manufacturing FZCO
World Headquarters
Tel. : +971 4 815 1111
Fax. : +971 4 815 1222
P.O.Box : 17014,
Dubai, United Arab Emirates.
Email. : info@naffco.ae
Web : www.naffco.com

Since these fire hydrants are pressure rated at 232 psi, much higher than the 125 psi system working pressure, it is curious why the hydrant seat valves continue to fail. It is possible that the plant operators are over tightening the hydrant operating nut. A minor future operational change could potentially alleviate this problem. In the future, the gate valve should be used to shut-off flow to the fire hydrants and the seating valve in the hydrant should be used to regulate flow from the hydrant. Using the seating valves as the shut-off valve for the hydrant may be what is causing the seat valves to fail. After using the hydrant, the gate valve should be closed and the hydrant should be closed; there is no need to "torque" hard on the operating nut of the hydrant.

2.0 Potential Short Term Solutions

The short term solutions below are aimed at temporarily providing fire suppression protection to the three (3) Power-House Buildings (A, B, and C) while permanent deficiency repairs are performed on the existing HDPE fire water distribution piping. USAID has stated that restoring the Power-House Buildings' fire suppression system as soon as possible is of paramount importance for insurance purposes. Three (3) alternatives were evaluated and detailed below. For a comparison of the estimated costs and construction schedule of each alternative, see the end of this section.

2.1 Short Term Alternative 1 – Provide Temporary Fire Suppression Using Existing Pump Station and Fire Water Storage Tank and Additional Temporary Lines

Short Term Alternative 1 will provide fire suppression to the existing Power-House Buildings utilizing the existing fire water storage tank and pump house.

Sufficient water storage and pumping capacity is available on site to suppress fires in the Power-House Buildings. A new manhole would be constructed near the south west corner of Power-House Building A. Repairs to the HDPE piping between the pump house and the new manhole need to be completed before this section of piping can be used as part of Short Term Alternative 1. Above ground restraint joint piping would be routed from the new manhole to the three (3) Power-House Buildings just before the existing pipe enters the building. A conceptual layout of the proposed branched piping route, cost estimate, and construction schedule are shown in Appendix 4, "Short Term Alternative 1." The cost estimate assumes the final reconstruction repair will not be completed by October 2013; therefore, insulation will be required for frost protection on the above ground pipe. Short Term Alternative 1 would cost approximately [redacted] and take approximately three (3) weeks to complete.

Alternative 1 – Advantages

- Lowest cost of all alternatives
- Shortest construction time
- Utilizes existing pump and water storage capacity
- No need to provide temporary storage and pumping capacity
- Relatively easy construction
- Would complete permanent repairs to the HDPE piping between the pump housed and new manhole location

Alternative 1 – Disadvantages

- Highest cost
- When compared to the other alternatives, this option has no disadvantages

2.2 Short Term - Alternative 2 – New Temporary Fire Suppression System

Short Term Alternative 2 will provide fire suppression to the existing Power-House Buildings utilizing new temporary fire water storage tank and pump facilities.

New water storage and pumping capacity would be leased or procured. The new tank would require a volume of fifty-five (55) cubic meters. A tank of this volume will provide sufficient fire water suppression for two (2) hours for one (1) Power-House Building with all sprinklers discharging. The pumping requirement, for a tank of this volume, to provide 125 psi of pressure at the Power-House Buildings is approximately twelve (12) horsepower (hp). The storage tank(s) will be located near the power house buildings to minimize the quantity of above ground piping requirements. As in Short Term Alternative 1, Short Term Alternative 2 requires that new temporary above ground restraint joint piping be routed from the temporary pump and pipe branches and connected to the three Power-House Buildings just before the existing pipe enters the building. A layout of the proposed piping route, cost estimate, and construction schedule are shown in Appendix 5, "Short Term Alternative 2." The cost estimate assumes the final reconstruction repair will not be completed by October 2013; therefore, insulation will be required for frost protection on the above ground pipe. Short Term Alternative 2 would cost approximately [redacted] and take approximately four (4) weeks to complete.

Alternative 2 - Advantages

- Relatively easy construction

Alternative 2 – Disadvantages

- Longest construction time due to procuring or leasing new pump and water storage tanks
- The temporary pump would be manually operated (the existing pump station operates on system pressure and is fully automated, this automatic pump is used in Alternatives 1 and 3)

2.3 Short Term - Alternative 3 – Repair and Isolate Portions of the Existing System

Short Term Alternative 3 will provide fire suppression to the existing Power-House Buildings utilizing existing repaired HDPE piping and the existing fire water storage tank and pump house.

Repairs to existing HDPE piping along the flow route to the existing Power-House Buildings will be completed to restore fire suppression capability. Sections of existing repaired pipe could be utilized and the valve positions configured to route fire water flow to the Power-House Buildings while the remaining HDPE piping is repaired. The approximate cost and construction time of Long Term Alternative 3 have not been calculated due to the infeasibility of the alternative.

Alternative 3 – Advantages

- Most cost efficient alternative
- Utilizes existing pump and water storage capacity, no need to provide temporary storage and pumping capacity
- No temporary pipe cost

Alternative 3 – Disadvantages

- The existing system may continue to fail resulting in lapses in fire protection as the existing HDPE pipes are under repair

Table 3
Short Term Alternatives Cost and Time Comparison

Short Term Alternatives	Cost (USD)	Construction Time
Short Term Alternative 1 Provide Temporary Fire Suppression Using Existing Pump Station and Fire Water Storage Tank and Additional Temporary Lines	[redacted]	3 weeks
Short Term Alternative 2 New Temporary Fire Suppression System	[redacted]	4 weeks
Short Term Alternative 3 Repair and Isolate Potions of the Existing System	Not Practical	Not Practical

2.4 Short Term Recommendation

The recommended short term alternative is Short Term Alternative 1, Provide Temporary Fire Suppression Using the Existing Pump and New Temporary Lines. Short Term Alternative 1 would cost approximately $28,000 and take approximately three (3) weeks to complete.

Short Term Alternative 1 utilizes the existing fire water storage and pump capacities of the plant. The initial section of pipe has had several of the HDPE pipe joints repaired between the pump house and Power-House Building A just before the existing pipe enters the building. After applying any necessary long term repairs to this section of pipe, the new manhole could be located near the south west corner of Power-House Building A. Locating the manhole here would minimize the required temporary piping requirements. The minimum pipe requirements, coupled with utilizing the existing water storage and pump facilities, and completing the long term repairs for a section of pipe-loop, make this alternative the most attractive out of the alternatives presented in prior sections. This alternative has the lowest cost and provides temporary full water supplied fire suppression service to the three Power-House Buildings. See Appendix 4, “Short Term Alternative 1” for the detailed cost of Short Term Alternative 1.

3.0 Potential Long Term Solutions

The long term solutions are aimed at permanently restoring complete fire suppression protection for Tarakhil TPP. Specifically, correcting or replacing existing defective HDPE fire water distribution piping. Three (3) alternatives were evaluated and are detailed below. For a comparison of the estimated costs and construction schedule of each alternative, see the end of this section.

3.1 Long Term Alternative 1 – Total Replacement of the Water Distribution System

Long Term Alternative 1 will require replacement of the existing HDPE piping including all 250 mm HDPE building connections and yard fire hydrant piping. The cost information for total replacement uses Schedule 80 PVC pipe with push on or flanged joints and thrust blocking at appurtenant fittings. The existing flanged gate valves and fire hydrants can be reused if found to be in working condition. Long Term Alternative 1 would cost approximately [redacted] and take approximately 9 weeks to complete. A cost estimate and construction schedule is shown in Appendix 6, "Long Term Alternative 1."

Alternative 1 – Advantages

- Reliability of a properly designed and constructed fire water pipe

Alternative 1 – Disadvantages

- Highest cost to procure and install system, under this alternative the entire system will be replaced requiring excavation, installation backfill, and restoration of the facility
- Time required to construct piping system and all the connections and plant restoration

3.2 Long Term Alternative 2 - Partial Replacement of the Water Distribution System

Under Long Term Alternative 2, select lines would be tested and, if suitable, would be left in place as part of the final repair. Lines to test could include the lines along the south, north, and east side of Power House Building C. These lines has proven to be free of leaks up until this point and are located primarily within a gravel area which could be easily replaced in the future should the need arise. See Section 1.0 Background, of this report, for a history of the HDPE piping.

To determine if there are additional leaks in the HDPE piping, the piping needs to be pressurized. If additional leaks are found, these leaks should be repaired. Once the repairs are complete, the HDPE piping could be pressure tested with the same PPI test procedures used in June 2012 and outlined in Section 1.0 Background, of this report.

If there are no additional leaks after pressure testing, the fire suppression system could be put into service. If additional leaks develop during the pressure testing, additional evaluation would be required.

Additional pressure testing could be used to identify leaks in specific sections of piping by configuring existing gate valves and isolating test segments of pipe. This testing would provide the required data to allow selective replacement of pipe sections instead of replacing the entire system.

After the test period, if it is determined that the entire system or parts of the system need to be replaced, the short term alternatives detailed in Section 2.0 and long term alternatives listed in the following sections should be implemented. Long Term Alternative 2 would cost approximately [redacted] Construction time has not been calculated for this option. A cost estimate and construction schedule is shown in Appendix 7, "Long Term Alternative 2."

Alternative 2 – Advantages

- Potential cost savings from salvaging select sections of existing pipe
- Potential shorter construction time than total replacement

Alternative 2 – Disadvantages

- Could cost more than option 1, if testing finds the pipes cannot be salvaged the system would need replacement anyway
- Cost savings could be insignificant when compared with Long Term Alternative 1
- Construction time could take longer than anticipated
- Leaks could develop in the salvaged sections of pipe
- There are many unknowns in this option

3.3 Long Term Alternative 3 – Install Liner inside of the Existing HDPE Pipe System.

Long Term Alternative 3 will require a contractor with specific expertise on how to install liner within existing HDPE pipes. There are many alternatives available for liners in the USA for HDPE pipe such as cured in place and slip lining. A specialty contractor with expertise to perform the work would be required. Research indicates that this work is not common in Kabul, Afghanistan. The process involves removing the valves, tees, and elbows, sliding a smaller diameter pipe inside the existing pipe, and grouting the void between the two and refitting the valves, tees, and elbows. This turns out to be an effective solution where there are long runs of difficult to remove pipe. Based on Tt's research, it seems there is a lack of expertise available in Afghanistan to perform such work, that the reduction of pipe diameter would require a substantial redesign of the system, and that the effort would be cost prohibitive in this environment. The approximate cost and construction time of Long Term Alternative 3 have not been calculated due to the infeasibility of the alternative.

Alternative 3 – Advantages

- Minimizes excavation

Alternative 3 – Disadvantages

- Most likely the highest cost

- Specialty contractor with expertise to perform the work in likely unavailable in Kabul, Afghanistan
- Not cost effective, pipe lining is commonly cost effective for deep pipe repairs in difficult excavation location such as highly developed areas or under highways that make open cut excavation difficult or impossible, however, existing HDPE water fire pipe is shallow and easily accessible for excavation
- Likely the longest construction time due to excavation ate the access pits at each of the system tees, valves, and elbows for installing the liner
- Hydraulic capacity of the pipe will be after the liner is installed
- Would still need to repair hydrants and building connections with other methods

Table 4
Long Term Alternatives Term Alternatives Cost and Time Comparison

Long Term Alternatives	**Cost (USD)**	**Construction Time**
Long Term Alternative 1 Total Replacement of the Water Distribution System	[redacted]	9 Weeks
Long Term Alternative 2 Partial Replacement of the Water Distribution System	[redacted]	No schedule provided
Long Term Alternative 3 Install Liner inside of the Existing HDPE Pipe System.	Not Practical	Not Practical

3.4 Long Term Recommendation

The purposes of the long term solutions are to permanently restore complete fire suppression protection for Tarakhil TPP.

The recommended long term alternative is Long Term Alternative 1, Total Replacement of the Water Distribution System. Long Term Alternative 1 would cost approximately [redacted] and take approximately nine (9) weeks to complete.

A total replacement of all HDPE pipe, including the 250 mm pipe-loop and all building and fire hydrant pipes would be the most reliable way to ensure a working fire suppression system. Schedule 80 PVC pipe was used to calculate the replacement cost. It may be possible to re-use the existing gate valves and water hydrants in the new pipe system if their operating condition is determined to be satisfactory. The existing defective HDPE pipe will be abandoned in place to minimize construction cost. A cost estimate and construction schedule is shown in Appendix 6, “Long Term Alternative 1.”

4.0 Conclusions

Based on the analysis within this report, a Short Term Recommendation and a Long Term Recommendation have been made along with other suggestions for improvement.

It is important to note again that the main objective of the short term alternatives is to temporarily provide fire suppression protection to the three Power-House Buildings (A, B, and C) while permanent deficiency repairs are performed on existing HDPE fire water piping. USAID has stated that for insurance purposes it is important to get the Power-House Buildings under the fire suppression system as soon as possible.

With this in mind, the recommended short term alternative is Short Term Alternative 1, Provide Temporary Fire Suppression Using the Existing Pump and New Temporary Lines. Short Term Alternative 1 would cost approximately [redacted] and take approximately three weeks to complete. See Appendix 4, "Short Term Alternative 1" for the detailed cost of Short Term Alternative 1.

The purposes of the long term solutions are to permanently restore complete fire suppression protection for Tarakhil TPP.

The recommended long term alternative is Long Term Alternative 1 – Total Replacement of the Water Distribution System. Long Term Alternative 1 would cost approximately [redacted] and take approximately nine weeks to complete. A cost estimate and construction schedule is provided in Appendix 6, "Long Term Alternative 1."

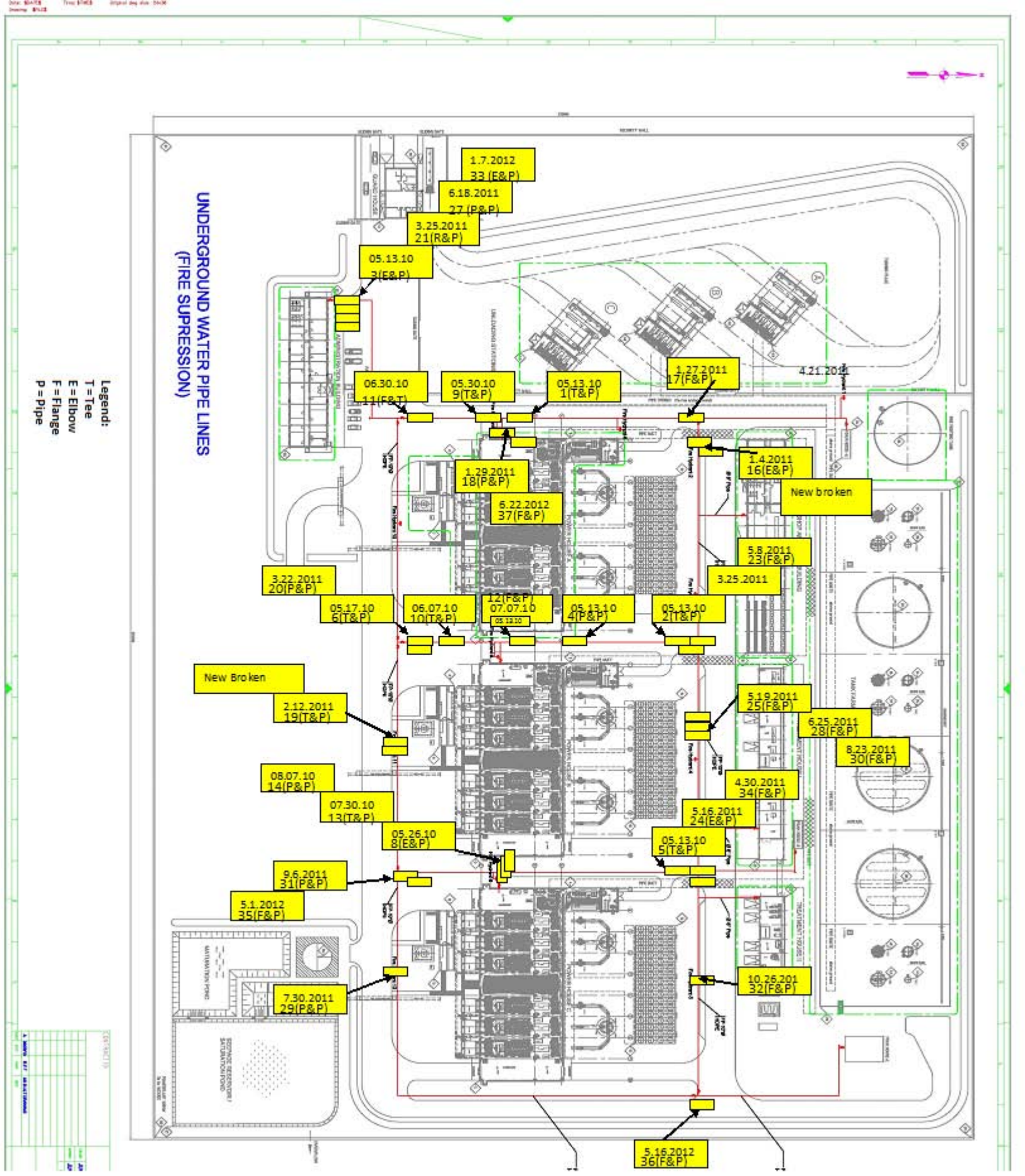
Regardless of the alternatives selected, flexible connections should be installed on the buildings connected to HDPE pipes. There have been significant repairs on all of the Power-House Building connections. Since these building connections are rigid pipes, slight differential settlement of the soil or seismic activity can put tremendous stresses on the ridged pipe building connection joints. Example manufacturer's cut sheets of flanged flexible fittings are located in Appendix 8, "Flexible Joint Cut Sheet."

The approximate cost to install flexible connections at Power-House Buildings A, B, and C is an additional [redacted] The approximate cost to install flexible connection at all buildings (10 total) is an additional [redacted] (these costs are already included in the recommended Long Term Alternative 1 – Total Replacement of the Water Distribution System).

Any new piping should be installed under stringent QA and QC procedures, including the selection of the construction contractor (potential contractors should be evaluated on reputation and cost), a thorough shop drawing review process, compacted backfilling, pipe pressure testing, and construction observation.

Appendices

Appendix 1 Pipe Repair Locations from DABS


UNDERGROUND WATER PIPE LINES
(FIRE SUPRESSION)
Legend:
T = Tee
E = Elbow
F = Flange
P = Pipe
1.7.2012
33 (E&P)
6.18.2011
27 (P&P)
3.25.2011
21(R&P)
05.13.10
3(E&P)
06.30.10
11(F&T)
05.30.10
9(T&P)
05.13.10
1(T&P)
1.27.2011
17(F&P)
4.21.2011
1.4.2011
16(E&P)
New broken
1.29.2011
18(P&P)
6.22.2012
37(F&P)
5.8.2011
23(F&P)
3.22.2011
20(P&P)
3.25.2011
05.17.10
6(T&P)
06.07.10
10(T&P)
12(F&P)
07.07.10
05.13.10
4(P&P)
05.13.10
2(T&P)
New Broken
2.12.2011
19(T&P)
5.19.2011
25(F&P)
6.25.2011
28(F&P)
8.23.2011
30(F&P)
08.07.10
14(P&P)
07.30.10
13(T&P)
4.30.2011
34(F&P)
5.16.2011
24(E&P)
05.26.10
8(E&P)
05.13.10
5(T&P)
9.6.2011
31(P&P)
5.1.2012
35(F&P)
7.30.2011
29(P&P)
10.26.201
32(F&P)
5.16.2012
36(F&P)

Appendix 2 DABS Fire Suppression System Reports

Fire Suppuration System Report

- LBG Black & Veatch give contract of completely work of TPP(Tarakhil Power Plant) to VICC and VICC give the contract section of fire suppuration system networking to Iranian company the name of company is (Pars)
  The pars company started work in TPP (Tarakhil Power Plant) on first September 2010 & they completed the networking of fire suppuration system on 30 November 2010 without warranty.

- They used HDPE pipe Pn10 in Network of fire suppuration system

- When the fire suppuration system is completed after that it's broken from the joint place 31 times in during 21 months.
  When Pars company handover this section of work to VICC after pressure test it's broken from the joint place in a week. The VICC company offer Pars Company for reappearing of the broken HDPE pipe fire suppuration system and Pars Company fixed it 7 times without any good result because each joint broken twice.
  After that VICC offer the reappearing of HDPE pipe to KAWCC (Kabul Amo Water Supply & Construction Company).
  The KAWCC did the work for 24 times successful.
  When KAWCC reappear the broken joint place & after the tested it's broken from the other joint place. When KAWCC active the fire suppuration system it worked for two days or more than two days but the longest time that fire suppuration system was active just for 20 days not more than that
  When VICC finished the warranty of this project LBG Black & Veatch offer to KAWCC for reappearing of the HDPE pipe fire suppuration system.
  KAWCC fixed or Wield 7 times the HDPE pipe of fire suppuration system for LGB /Black & Veatch.
  LBG / Black & Veatch had a meeting in TPP (Tarakhil Power Plant) & invited several company to be attend for solution of the fire suppuration system problem.
  LBG/B&V taught to all company that we want to solve this problem of fire suppuration system & what is the main point that we avoid from this problem.
  Every company given them opinions to LBG but LBG approved solution of KAWCC.

  Regarding of basic problems of fire suppuration system KAWCC give the complete information to LBG/Black & Veatch. There was several reasons that we face with broken or dative of fire suppuration system which I mention as a following.

  - ✓ Piping of network for the fire suppuration system should be change or replace cause the raw material of HDPE pipe which they used in TPP(Tarakhil Power Plant) PE100 it is not suitable for that much power the must use PE80.
  - ✓ The pipe which used here wall thickness is very week cause of PN10, they must use Pn16.

- ✓ The trench which excavated for the HDPE pipe it was not in same level because when the KAWCC fixed the broken pipe on site of NLCC Building They saw the miss level here, it needs to be equal level.
- ✓ The Pipe and fitting instrument was not from same company because of that wall thickness of the pipe & fitting not matched with each other.
- ✓ They did not followed standard procedure the welding of HDPE pipe such as, facing of the pipe with fitting , making all surface of the pipe in equal level, cleaning of the welding place with the special materials, making the pressure gage off hydraulic machine according to standard procedure .
- ✓ KAWCC suggest to LBG we should make instate of this valve box manholes which a person can go inter & fix the problem of valve or replace the valve easily & it can avoid From the exuviating concrete.
  Therefore LBG / Black & Veatch approved this method of work and he give the contract to KAWCC to make manholes there cause of short time LBG couldn't be able to make all of that just they made one of that which is located between PCR B & PCR C.

Respectfully

[redacted]

Tarakhil power plant Manager

28.07.2012

REPORT FOR THE FIRE SUPRESSION SYSTEM

No	Broking Date	Reappearing Date	Re-Testing Date	Activaty of fire supreission since 2010 up to2012	Who Reappear the Brokan Joint	Place of Broke
1	5/13/2010	5/132010	5/13/2010	Stop	Afghan pars	T&P
2	5/13/2010	5/132010	5/13/2010	Stop	Afghan pars	T&P
3	5/13/2010	5/132010	5/13/2010	Stop	Afghan pars	E& P
4	5/13/2010	5/132010	5/13/2010	Stop	Afghan pars	P&P
5	5/13/2010	5/132010	5/13/2010	Stop	Afghan pars	T&P
6	5/17/2101	19/5/2010	5/20/2010	4 days opration run	KAWCC	T&P
7	5/24/2010	25/5/2010	5/26/2010	stop	KAWCC	T&P
8	5/26/2010	27/5/2010	5/27/2010	3 days opration run	KAWCC	E&P
9	5/30/2010	6/2/2010	6/2/2010	5 days opration run	KAWCC	T&P
10	6/7/2010	6/15/2010	6/19/2010	11 days opration run	KAWCC	T&P
11	6/30/2010	7/3/2010	7/1/2010	6 days opration run	KAWCC	F&T
12	7/7/2010	7/19/2010	7/20/210	11 days opration run	KAWCC	F8P
13	7/30/2010	8/4/2010	8/4/2010	2 days opration run	KAWCC	T&P
14	8/7/2010	8/20/2010	8/28/2010	3 days opration run	KAWCC	P&P
15	9/1/2010	9/19/2010	9/20/2010	25 days opration run	KAWCC	F&E
16	1/4/2011	1/10/2011	1/11/2011	16 days opration run	KAWCC	E&P
17	1/27/2011	1/27/2011	1/29/2011	Stop	KAWCC	F&P
18	1/29/2011	2/4/2011	2/5/2011	7 days opration run	KAWCC	P&P
19	2/12/2011	3/4/2011	3/3/2011	19 days opration run	KAWCC	T&P
20	3/22/2011	3/24/2011	3/25/2011	Stop	KAWCC	P&P
21	3/25/2011	4/19/2011	4/19/2011	2 days opration run	KAWCC	R&P
22	4/21/2011	5/7/2011	5/8/2011	Stop	KAWCC	R&F
23	5/8/2011	5/14/2011	5/14/2011	1 days opration run	KAWCC	F&P
24	5/16/2011	5/17/2011	5/17/2011	1 days opration run	KAWCC	E&P
25	5/19/2011	6/10/2011	6/11/2011	6 days opration run	KAWCC	F&P
26	6/18/2011	6/22/2011	6/25/2011	Stop	KAWCC	R&F
27	6/18/2011	6/23/2011	6/25/2011	Stop	KAWCC	P&P
28	6/25/2011	7/15/2011	7/16/2011	1 4 days opration run	KAWCC	F&P
29	7/30/2011	8/15/2011	8/15/2011	8 days opration run	KAWCC	P&P
30	8/23/2011	9/4/2011	9/4/2011	2 days opration run	KAWCC	F&P
31	9/6/2011	9/23/2011	9/24/2011	1 days opration run	KAWCC	P&P
32	10/26/2011	1/6/2012	1/7/2012	Stop	KAWCC	F&P
33	1/7/2012	4/29/2012	4/30/2012	3 days opration run	KAWCC	E&P
34	4/30/2012	4/30/2012	5/1/2012	Stop	KAWCC	F&P
35	5/1/2012	5/14/2012	5/15/2012	1 days opration run	KAWCC	F&P
36	5/16/2012	5/25/2012	5/25/2012	10 days operation run	KAWCC	F&P
37	6/22/2012	7/11/2012		Stop	DABS	F&P
38	12/2/2013			Stop		under ground
39	12/2/2013			Stop		hydrant
40	12/3/2013			Stop		hydrant

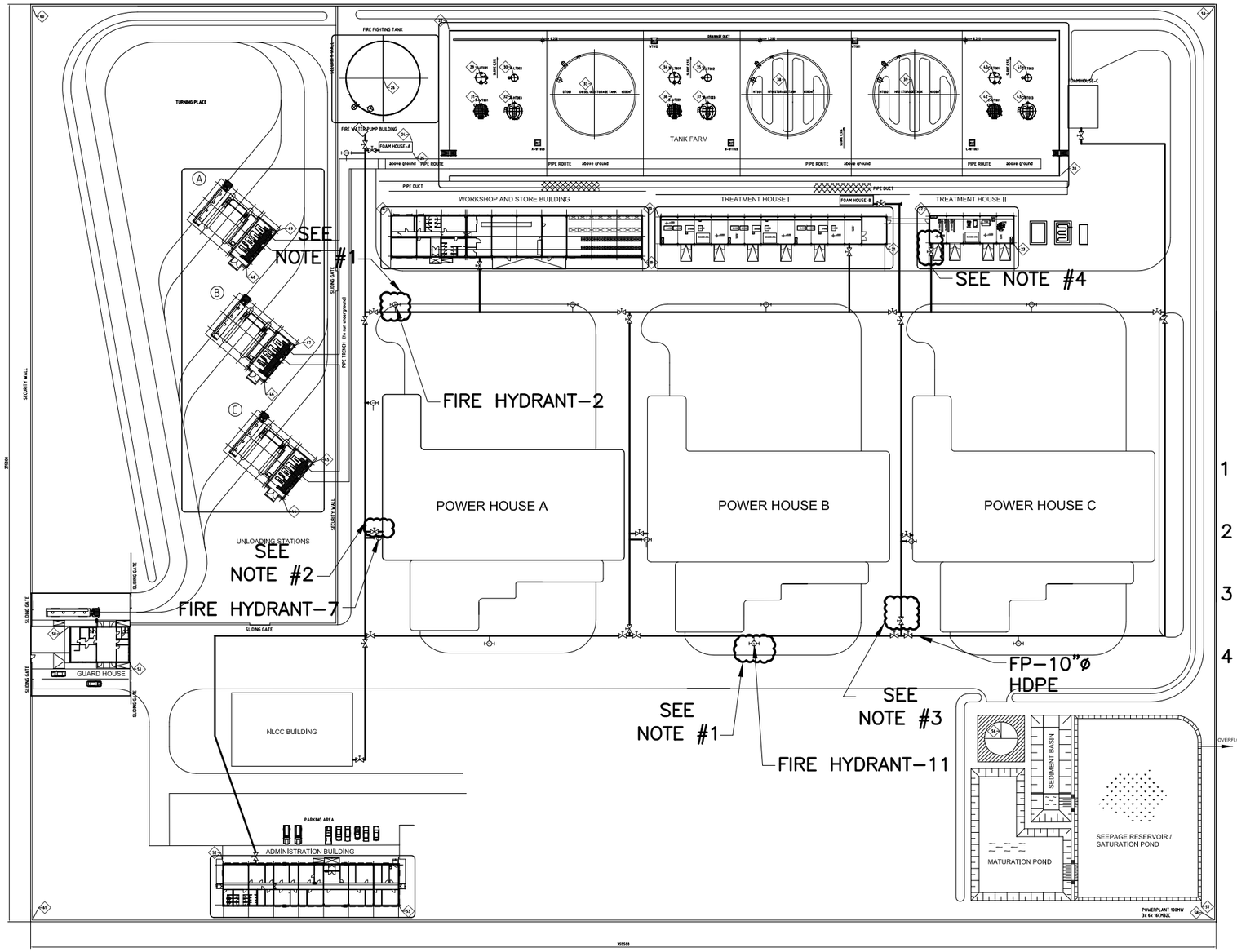
VICC means; Venco Imtiaz Construction Company.

VICC has handed over the civil work to LBG by may 2010 and thy have finished their warranty by may 2011

you can see the broken times under warranty from May 2010 up to may 2011 there is 24 times.

Meaning of symbols P=Pipe R=Resucer E=Elbow F=Flange T=Tea

Appendix 3 Existing System Deficiencies



UNDERGROUND WATER PIPE LINES
(FIRE SUPRESSION)

NOTES:–

1 FIRE HYDRANT SEAT BROKEN, NOT FIXED YET.

2 THE LEAKAGE FIXED ON JULY 11 2012.

3 UNDERGROUND UNKNOWN SYSTEM LEAK NEAR THE GATE–VALVE

4 LEAKAGE AT GATE VALVE

This project was made possible by the United States Agency for International Development and the generous support of the American People through USAID Global Architecture and Engineering IQC Contracts.

XXXX SUBMITTAL

SYMB	SUBMITTAL/REVISION DESCRIPTION	DATE	APR
A	XXXXXXX DESIGN SUBMITTAL	DD/MM/YY	XXX

DESIGNED BY: DATE: DD–MM–YY
DRAWN BY: SUBMITTED BY: TETRA TECH
CHECKED BY: CAD FILE NAME:

USAID FROM THE AMERICAN PEOPLE

AESP

DRAFT

USAID – OEGI
PROJECT NAME
PROJECT LOCATION, AFGHANISTAN

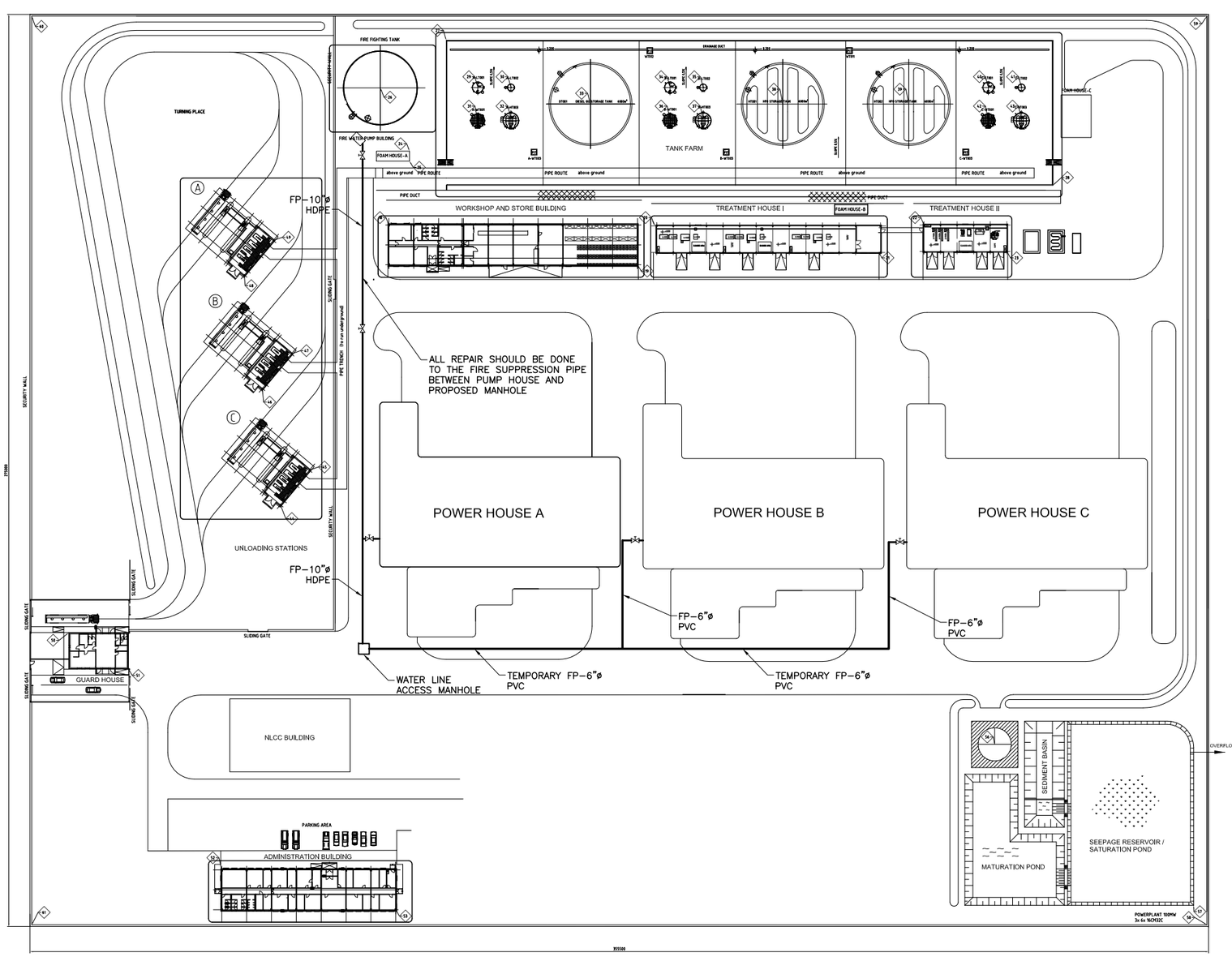
SHEET REFERENCE NUMBER:
LT00XX

UNLESS OTHERWISE NOTED, LINEAR DIMENSIONS SHOWN ARE IN METERS.

NOTE: A3 SIZE REDUCED TO HALF SCALE.

P:\1298\Work Orders\WO–A\WO–A–0090 Tarakhil PP Fire Suppression Component Analysis\CAD\Conceptual\Underground water lines–Leaks.dwg 4/2/2013 9:13:48 AM Safai, Ahmad Shekib

Appendix 4 Short Term Alternative 1



LEGEND FOR SYMBOLS

FP – FIRE PROTECTION

SHORT TERM
SITE WATER NETWORK PLAN
ST–ALTERNATIVE # 1

SCALE 1:750

UNLESS OTHERWISE NOTED, LINEAR DIMENSIONS SHOWN ARE IN METERS.

NOTE: A3 SIZE REDUCED TO HALF SCALE.

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XXXX SUBMITTAL

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DESIGNED BY: DATE: DD–MM–YY
DRAWN BY: SUBMITTED BY: TETRA TECH
CHECKED BY: CAD FILE NAME:

USAID FROM THE AMERICAN PEOPLE

AESP

DRAFT

USAID – OEGI
PROJECT NAME
PROJECT LOCATION, AFGHANISTAN

SHEET REFERENCE NUMBER:
LT00XX

Bill of Quantities

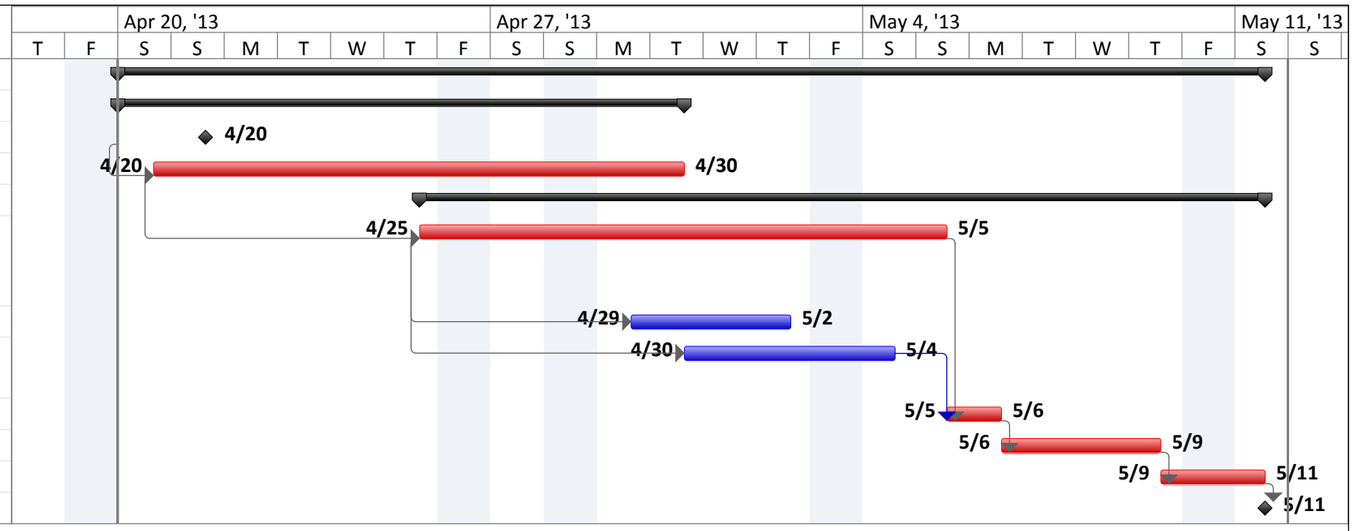
Summary of Bill of Quantities for Short Term (ST)

Bill No.	Description		Price
1	Alternative ST - 1	$	[redacted]

Bill No. Alternative ST - 1

Item No.	Description	Unit	Qty.	Unit Price	Price
1.01	6 inch Schedule 80 PVC Pipe with installation	LM	250	[redacted]	[redacted]
1.02	6inch Schedule 80 PVC elbow	Ea.	8		
1.03	6inch Schedule 80 PVC Tee fitting	Ea.	1		
1.04	6 inch PVC flange joint	Ea.	42		
1.05	Transition Flange from HDPE to PVC with installation	Ea.	3		
1.06	Flexible Joint with installation	Ea.	3		
1.07	Construction of water line access Man-hole	LS	1		
1.08	Clamp for the support of water pipe	Ea.	85		
1.09	Insulation cost for above ground water pipe for the winter season	LM	250		
	Sub Total				
1.10	20 % for Contingency				
1.11	20 % for the contractor Overhead and Profit				
	Grand Total				

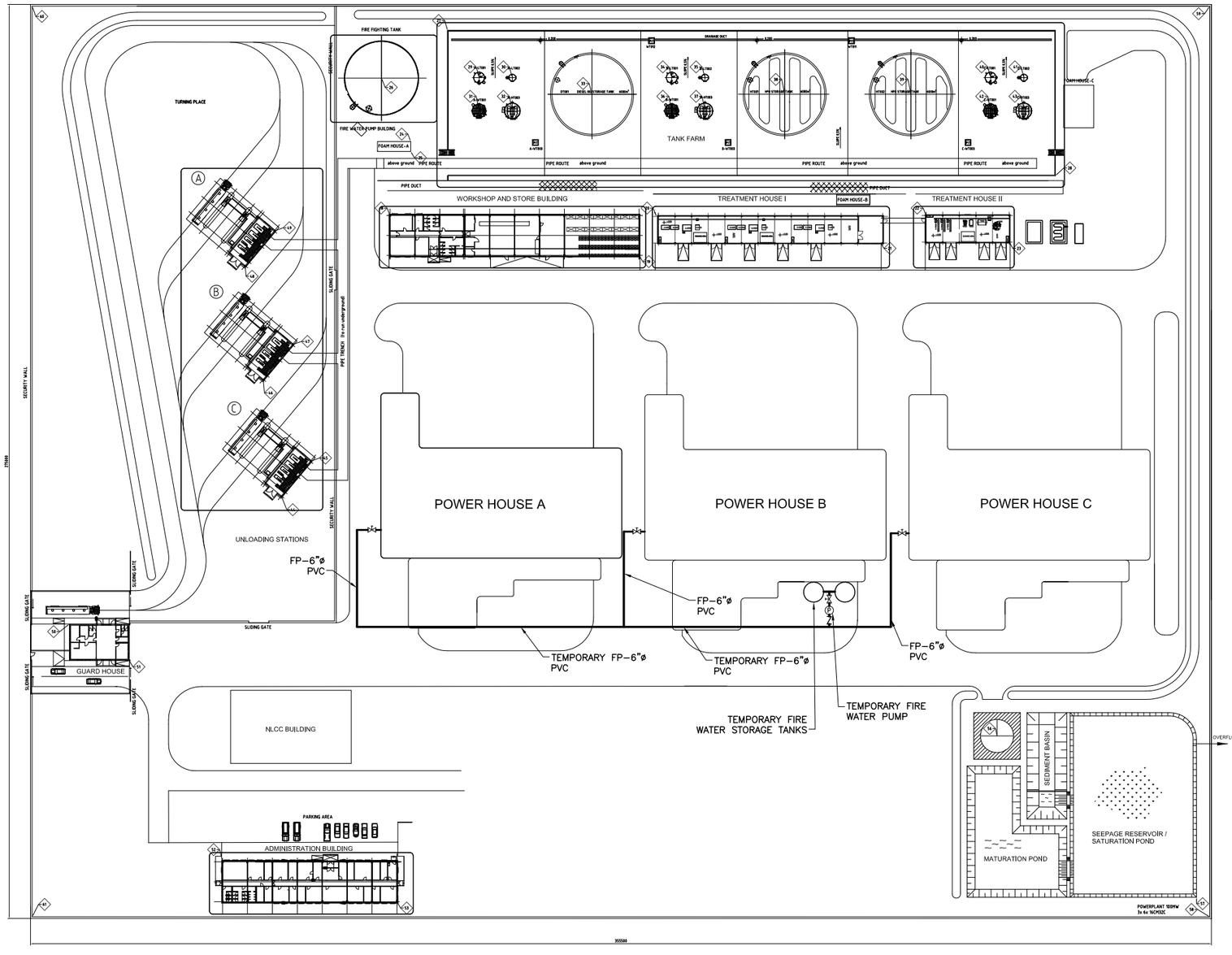
ID	Task Mode	Task Name	Duration	Start	Finish
1		**Short Term Fix Alternative #1**	**18 days**	**Sat 4/20/13**	**Sat 5/11/13**
2		**Preliminary and General**	**9 days**	**Sat 4/20/13**	**Tue 4/30/13**
3		Mobilization	2 days	Sat 4/20/13	Sun 4/21/13
4		Submittals and procurement	8 days	Sat 4/20/13	Tue 4/30/13
5		**Construction**	**12 days**	**Thu 4/25/13**	**Sat 5/11/13**
6		Supply and install 6 inch Schedule 80 PVC Pipe with flanged fittings and accessories	7 days	Thu 4/25/13	Sun 5/5/13
7		Construct water line access Man-hole	3 days	Mon 4/29/13	Thu 5/2/13
8		Supply and install clamp for the support of water pipes	3 days	Tue 4/30/13	Sat 5/4/13
9		Test the system	1 day	Sun 5/5/13	Mon 5/6/13
10		Miscellaneous works and fixes	3 days	Mon 5/6/13	Thu 5/9/13
11		Clean the site and demobilize	1 day	Thu 5/9/13	Sat 5/11/13
12		Complete Task	0 days	Sat 5/11/13	Sat 5/11/13



Project: Tarakhil Powerplant Fire
Date: Thu 3/28/13

Task		Group By Summary		External Tasks		Manual Task		Finish-only	
Split		Rolled Up Task		External Milestone		Duration-only		Deadline	
Milestone		Rolled Up Critical Task		Inactive Task		Manual Summary Rollup		Critical Task	
Summary		Rolled Up Milestone		Inactive Milestone		Manual Summary		Progress	
Project Summary		Rolled Up Progress		Inactive Summary		Start-only			

Appendix 5 Short Term Alternative 2



LEGEND FOR SYMBOLS

FH – FIRE HYDRANT

ISV – ISOLATION VALVE

FP – FIRE PROTECTION

SHORT TERM
SITE WATER NETWORK PLAN
ST–ALTERNATIVE # 2

SCALE 1:750

UNLESS OTHERWISE NOTED, LINEAR DIMENSIONS SHOWN ARE IN METERS.

NOTE: A3 SIZE REDUCED TO HALF SCALE.

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XXXX SUBMITTAL

SYMB	DESCRIPTION	DATE
A	XXXXXXX DESIGN SUBMITTAL	DD/MM/YY
	SUBMITTAL/REVISION	APR

DESIGNED BY:
DRAWN BY:
CHECKED BY:
DATE: DD–MM–YY
SUBMITTED BY: TETRA TECH
CAD FILE NAME:

USAID FROM THE AMERICAN PEOPLE

AESP

DRAFT

USAID – OEGI
PROJECT NAME
PROJECT LOCATION, AFGHANISTAN

SHEET REFERENCE NUMBER:
LT00XX

P:\1298\Work Orders\WO-A\WO-A-0090 Tarakhil PP Fire Suppression Component Analysis\CAD\Conceptual\Short Term Site Water Network Plan Alternative #2.dwg 3/31/2013 11:16:16 AM Safai, Ahmad Shekib

Bill of Quantities

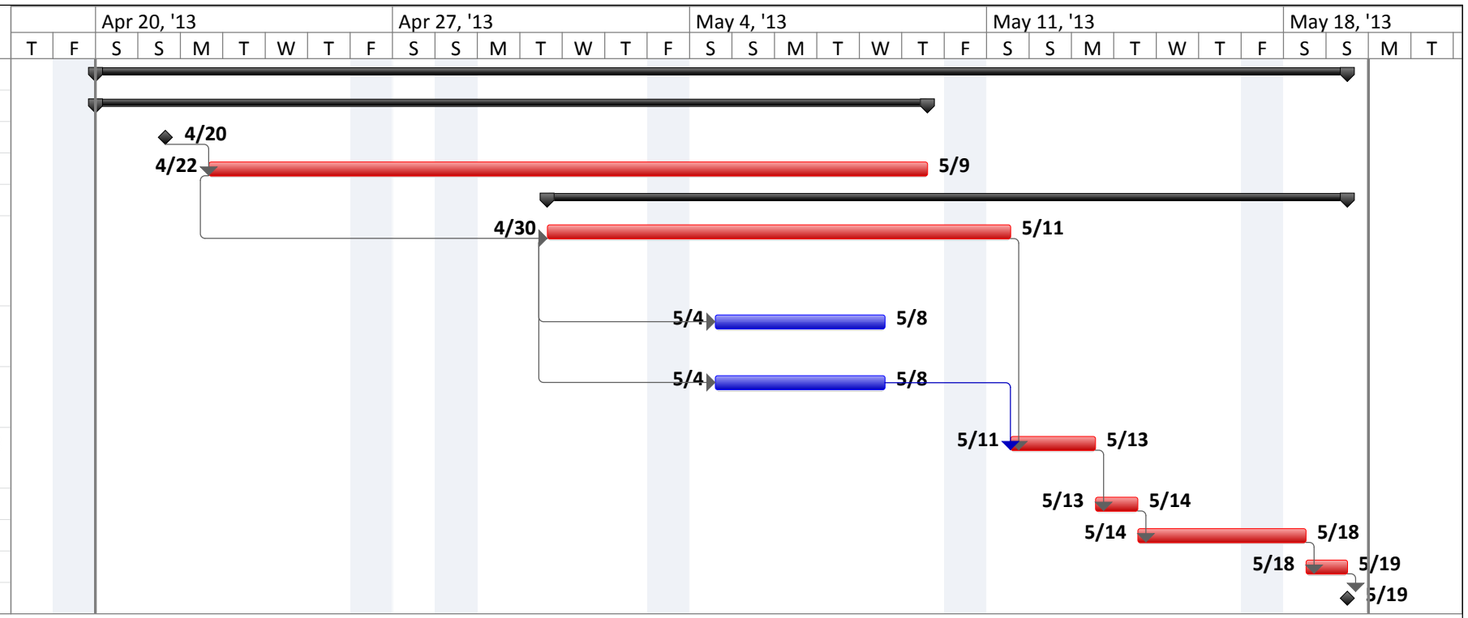
Summary of Bill of Quantities for Short Term (ST)

Bill No.	Description		Price
1	Alternative ST - 2	$	[redacted]

Bill No. Alternative ST - 2

Item No.	Description	Unit	Qty.	Unit Price	Price
1.01	6 inch Schedule 80 PVC Pipe with installation	LM	300	[redacted]	
1.02	6inch Schedule 80 PVC elbow	Ea.	10		
1.03	6inch Schedule 80 PVC Tee fitting	Ea.	1		
1.04	6 inch Check Valve	Ea.	1		
1.05	6 inch Gate Valve	Ea.	1		
1.06	27500 liter water storage tank	Ea.	2		
1.07	Flexible Joint with installation	Ea.	3		
1.08	Clamp for the support of water pipe	Ea.	100		
1.09	20 Horse Power Fire Water Pump	Ea.	1		
1.10	Insulation cost for above ground water pipe for the winter season	LM	300		
	Sub Total				
1.11	20 % for Contingency				
1.12	20 % for the contractor Overhead and Profit				
	Grand Total				

ID	Task Name	Duration	Start	Finish
1	**Short Term Fix Alternative #2**	**25 days**	**Sat 4/20/13**	**Sun 5/19/13**
2	**Preliminary and General**	**17 days**	**Sat 4/20/13**	**Thu 5/9/13**
3	Mobilization	2 days	Sat 4/20/13	Sun 4/21/13
4	Submittals and procurement	14 days	Mon 4/22/13	Thu 5/9/13
5	**Construction**	**16 days**	**Tue 4/30/13**	**Sun 5/19/13**
6	Supply and install 6 inch Schedule 80 PVC Pipe with flanged fittings,valves and accessories	9 days	Tue 4/30/13	Sat 5/11/13
7	Supply and install clamp for the support of water pipes	4 days	Sat 5/4/13	Wed 5/8/13
8	Supply and install two water tanks each 55000 liter capacity	4 days	Sat 5/4/13	Wed 5/8/13
9	Supply and install 20HP capacity fire water pump	2 days	Sat 5/11/13	Mon 5/13/13
10	Test the system	1 day	Mon 5/13/13	Tue 5/14/13
11	Miscellaneous works and fixes	3 days	Tue 5/14/13	Sat 5/18/13
12	Clean the site and demobilize	1 day	Sat 5/18/13	Sun 5/19/13
13	Complete Task	0 days	Sun 5/19/13	Sun 5/19/13



Project: Tarakhil Powerplant Fire
Date: Thu 3/28/13

Task		Group By Summary		External Tasks		Manual Task		Finish-only	
Split		Rolled Up Task		External Milestone		Duration-only		Deadline	
Milestone		Rolled Up Critical Task		Inactive Task		Manual Summary Rollup		Critical Task	
Summary		Rolled Up Milestone		Inactive Milestone		Manual Summary		Progress	
Project Summary		Rolled Up Progress		Inactive Summary		Start-only			

Appendix 6 Long Term Alternative 1

Bill of Quantities

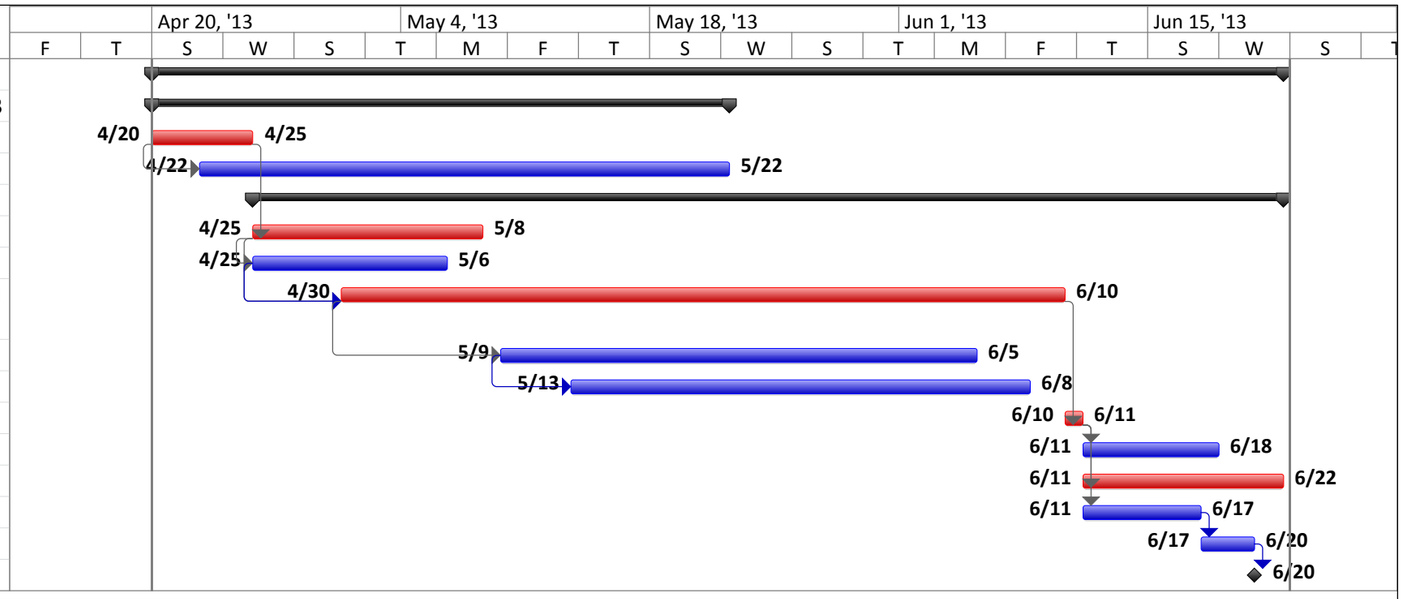
Summary of Bill of Quantities for Long Term Alternative LT-1

Bill No.	Description		Price
1	**Alternative LT-1 :** Complete replacement of the Water Distribution System with flange restrained DIP joint fittings and thrust blocking.	**$**	[redacted]

Bill No.1 **Alternative LT-1 :** Complete replacement with flange restrained DIP joint fittings and thrust blocking.

Item No.	Description	Unit	Qty.	Unit Price	Price
1.01	6 inch Schedule 80 PVC Pipe with installation	LM	48	[redacted]	
1.02	10-6 inch DIP Tee fitting	Ea.	12		
1.03	6 inch PVC flange joint	Ea.	48		
1.04	8 inch Schedule 80 PVC Pipe with installation	LM	140		
1.05	8inch DIP elbow	Ea.	22		
1.06	10-8 inch DIP Tee fitting	Ea.	7		
1.07	8 inch PVC flange joint	Ea.	95		
1.08	10 inch Schedule 80 PVC Pipe with installation	LM	1140		
1.09	10 inch DIP elbow	Ea.	7		
1.10	10 inch DIP Tee fitting	Ea.	8		
1.11	10 inch PVC flange joint	Ea.	70		
1.12	Flexible Joint with installation	Ea.	11		
1.13	Excavation	CM	1328		
1.14	Backfilling & Compaction	CM	1328		
1.15	Sand	CM	265		
1.16	Thrust Blocking	CM	46		
	Sub Total				
1.17	20 % for Contingency				
1.18	20 % for the contractor Overhead and Profit				
	Grand Total				

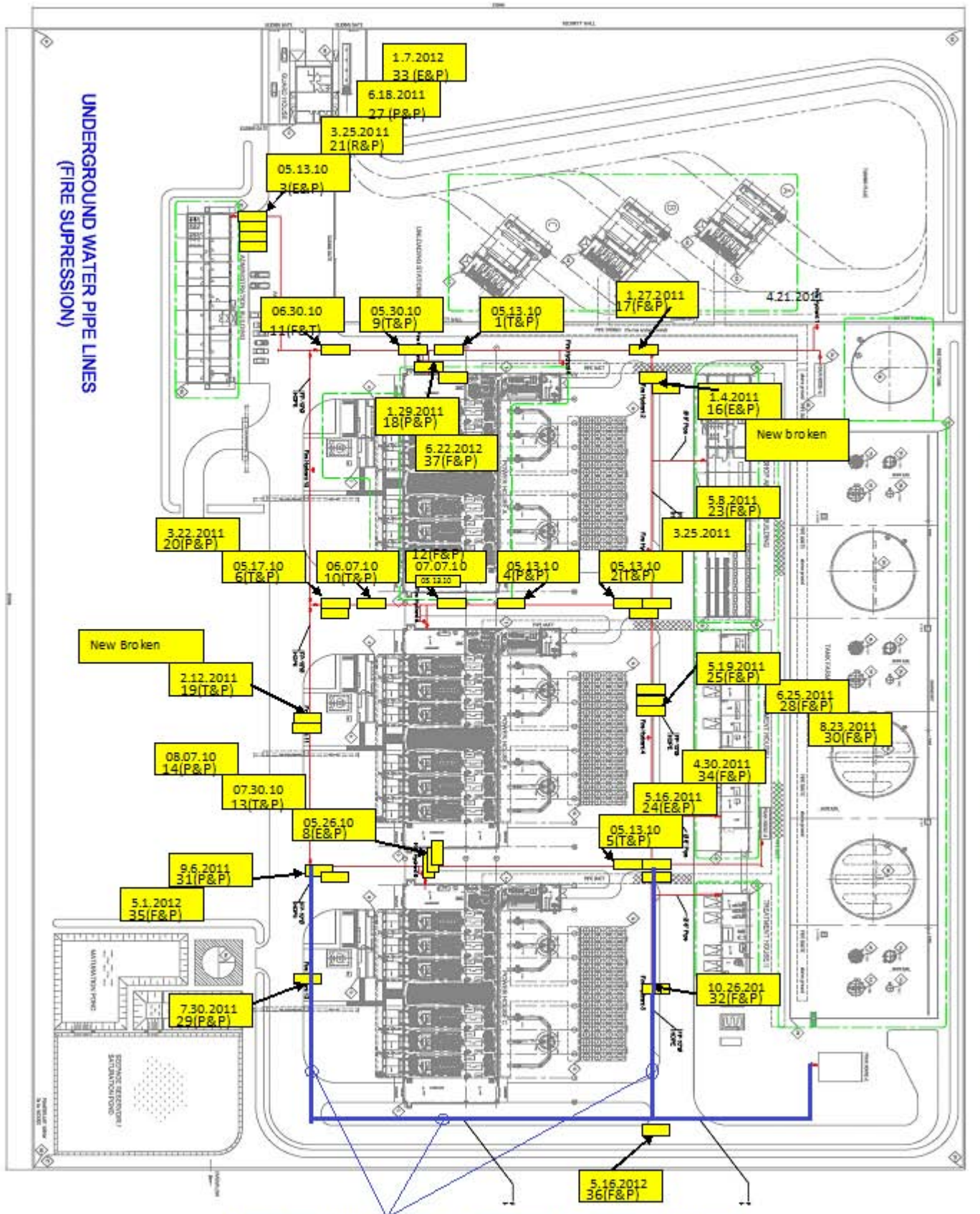
ID	Task Name	Duration	Start	Finish
1	**Total System Replacement Alternative #1 (Long Term)**	**55 days**	**Sat 4/20/13**	**Sat 6/22/13**
2	**Preliminary and General**	**28 days**	**Sat 4/20/13**	**Wed 5/22/13**
3	Mobilization	6 days	Sat 4/20/13	Thu 4/25/13
4	Submittals and procurement	25 days	Mon 4/22/13	Wed 5/22/13
5	**Construction**	**49 days**	**Thu 4/25/13**	**Sat 6/22/13**
6	Excavation and sand bedding	10 days	Thu 4/25/13	Wed 5/8/13
7	Existing concrete demolition	8 days	Thu 4/25/13	Mon 5/6/13
8	Supply and install Schedule 80 PVC Pipe with flanged fittings,valves and accessories	35 days	Tue 4/30/13	Mon 6/10/13
9	Cast thrust blocks	23 days	Thu 5/9/13	Wed 6/5/13
10	Backfill and compact trenches	22 days	Mon 5/13/13	Sat 6/8/13
11	Test the system	1 day	Mon 6/10/13	Tue 6/11/13
12	Repair demolished parts of concrete work	7 days	Tue 6/11/13	Tue 6/18/13
13	Backkfill exposed joints	10 days	Tue 6/11/13	Sat 6/22/13
14	Miscellaneous works and fixes	6 days	Tue 6/11/13	Mon 6/17/13
15	Clean the site and demobilize	3 days	Mon 6/17/13	Thu 6/20/13
16	Complete Task	0 days	Thu 6/20/13	Thu 6/20/13



Project: TTP Fire Supression Syste
Date: 28-Mar-2013

Task		Group By Summary		External Tasks		Manual Task		Finish-only	
Split		Rolled Up Task		External Milestone		Duration-only		Deadline	
Milestone		Rolled Up Critical Task		Inactive Task		Manual Summary Rollup		Critical Task	
Summary		Rolled Up Milestone		Inactive Milestone		Manual Summary		Progress	
Project Summary		Rolled Up Progress		Inactive Summary		Start-only			

Appendix 7 Long Term Alternative 2


UNDERGROUND WATER PIPE LINES
(FIRE SUPRESSION)
1.7.2012
33 (E&P)
6.18.2011
27 (P&P)
3.25.2011
21(R&P)
05.13.10
3(E&P)
06.30.10
11(F&T)
05.30.10
9(T&P)
05.13.10
1(T&P)
1.27.2011
17(F&P)
4.21.2011
1.4.2011
16(E&P)
New broken
1.29.2011
18(P&P)
6.22.2012
37(F&P)
5.8.2011
23(F&P)
3.22.2011
20(P&P)
3.25.2011
05.17.10
6(T&P)
06.07.10
10(T&P)
12(F&P)
07.07.10
05.13.10
4(P&P)
05.13.10
2(T&P)
New Broken
2.12.2011
19(T&P)
5.19.2011
25(F&P)
6.25.2011
28(F&P)
8.23.2011
30(F&P)
08.07.10
14(P&P)
07.30.10
13(T&P)
4.30.2011
34(F&P)
5.16.2011
24(E&P)
05.26.10
8(E&P)
05.13.10
5(T&P)
9.6.2011
31(P&P)
5.1.2012
35(F&P)
7.30.2011
29(P&P)
10.26.201
32(F&P)
5.16.2012
36(F&P)
East Loop of HDPE Pipe with Few Recorded Repairs THAT MAYBE SALVAGEABLE (After verification from selective pressure testing)

Bill of Quantities

Summary of Bill of Quantities for Long Term Alternative LT-2

Bill No.	Description		Price
1	**Alternative LT-2 :** Partial Replacement of the Water Distribution System with flange restrained DIP joint fittings and thrust blocking.	**$**	[redacted]

Bill No.1 **Alternative LT-2 :** Partial Replacement with flange restrained DIP joint fittings and thrust blocking.

Item No.	Description	Unit	Qty.	Unit Price	Price
1.01	6 inch Schedule 80 PVC Pipe with installation	LM	40	[redacted]	
1.02	10-6 inch DIP Tee fitting	Ea.	10		
1.03	6 inch PVC flange joint	Ea.	40		
1.04	8 inch Schedule 80 PVC Pipe with installation	LM	115		
1.05	8inch DIP elbow	Ea.	17		
1.06	10-8 inch DIP Tee fitting	Ea.	6		
1.07	8 inch PVC flange joint	Ea.	81		
1.08	10 inch Schedule 80 PVC Pipe with installation	LM	810		
1.09	10inch DIP elbow	Ea.	5		
1.10	10inch DIP Tee fitting	Ea.	7		
1.11	10 inch PVC flange joint	Ea.	53		
1.12	Flexible Joint with installation	Ea.	9		
1.13	Excavation	CM	965		
1.14	Backfilling & Compaction	CM	965		
1.15	Sand	CM	193		
1.16	Thrust Blocking	CM	38		
	Sub Total				
1.17	20 % for Contingency				
1.18	20 % for the contractor Overhead and Profit				
	Grand Total				

Appendix 8 Flexible Joint Cut Sheet

TYPE	Single Sphere (ลอนเดี่ยว)				
					
	Pressure 228 Psi./Burst Pressure 854 Psi				
	L	ANSI 150	JIS 10 k	PN 10	PN 16
	(MM.)	EPDM (งานน้ำ,สารเคมี)			
SIZE	MODEL PTS				
1"	-	700	780	780	780
1-1/4"	-	720	820	1,020	1,020
1-1/2"	95	800	860	1,080	1,080
2"	105	980	1020	1,340	1,340
2-1/2"	115	1,340	1,260	1,780	1,780
3"	130	1,600	1,500	2,100	2,100
4"	135	2,080	1,860	2,540	2,540
5"	170	3,080	2,500	3,720	3,720
6"	180	3,560	3,200	4,520	4,520
8"	205	5,660	4,920	6,280	6,280
10"	240	8,040	7,640	8,240	8,920
12"	260	10,700	9,100	10,480	11,380

TYPE	Twin Sphere (ลอนคู่)				
					
	Pressure 228 Psi./Burst Pressure 854 Psi				
	L	ANSI 150	JIS 10 k	PN 10	PN 16
	(MM.)	EPDM (งานน้ำ,สารเคมี)			
SIZE	MODEL PTS				
1"	-	-	-	-	-
1-1/4"	-	940	980	1,160	1,160
1-1/2"	175	960	1,000	1,200	1,200
2"		1,220	1,200	1,500	1,500
2-1/2"		1,560	1,600	1,880	1,880
3"		1,880	1,880	2,120	2,120
4"	225	2,860	2,800	3,120	3,120
5"		3,920	3,620	4,220	4,220
6"		4,460	4,340	5,140	5,140
8"	325	7,580	7,400	7,760	7,760
10"		11,860	11,640	13,800	14,500
12"		14,860	14,000	16,440	16,960

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